NASA Facts

National Aeronautics and
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Glenn Research Center
Cleveland, Ohio 44135–3191

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The Glenn Research Center:
Expanding Horizons and Opening Frontiers

The men and women of the NASA John H. Glenn Research Center at Lewis Field have, since 1941, been the pioneers and innovators whose work has expanded horizons and opened frontiers for our explorers in air and space. The Center defines and develops propulsion, space electrical power, and communications technologies for NASA's aeronautics and space missions.

Building upon the knowledge and experience that have fueled many of the great achievements of NASA, the world-class research at the Glenn Research Center today addresses the technology needs of the future. What is more, NASA Glenn transfers much of the technology developed from that research to U.S. industry. Whether it is about new communication bandwidths, soot accretion inside a furnace, or how liquids become solids, this knowledge-expanding research is the engine that helps bring about NASA's missions and spark the American economy.

Pioneering Spirit

In groundbreaking ceremonies held at the site in Cleveland, Ohio, on January 23, 1941, the National Advisory Committee for Aeronautics (NACA) established its third aeronautics research facility, the Aircraft Engine Research Laboratory. The Laboratory's initial mission was to advance American engine development to keep stride with the Europeans. Some of the Laboratory's early tasks were to help in the World War II effort by developing a cooling system for the B-29 Superfortress and by studying aircraft icing to help planes fly "the hump" over the Himalayas into China.

In the late 1940's the Cleveland Laboratory was renamed first the Flight Propulsion Research Laboratory then, following the death of NACA aeronautics pioneer George W. Lewis in 1948, the Lewis Flight Propulsion Laboratory. The change marked the transition from a laboratory limited to aircraft engines to one free to explore all areas propulsion research.

Before most people realized that the Space Age was dawning, engineers and scientists at the Lewis laboratory were pioneering rocket-engine and fuels research. The Lab first began work with liquid hydrogen as a high-powered rocket fuel in 1945. That pioneering work lead, after another name change, to one of its most significant achievements thus far—the development of the Centaur rocket, the most powerful upper stage in the U.S. space program.

The U.S. space program began in earnest in 1958 when the U.S. Space Act dissolved NACA and created in its place the National Aeronautics and Space Administration. The Lewis laboratory became part of the foundation of the new agency and was renamed the Lewis Research Center.

In 1963 the Lewis Center successfully launched its first Atlas/Centaur rocket. And for the next 35 years, Lewis experts managed the launch of the Atlas/Centaur and Titan/Centaur booster vehicles and the Agena upper stage rockets. Those launches sent to the sky weather and communications satellites and planetary exploration spacecraft, such as Surveyor, Pioneer, Viking, and Voyager which studied the Moon, Mars, and the outer planets. All together, Lewis managed more than 119 unmanned launches.

The Centaur technology developed in those early days was used in the upper stages of the Saturn V rockets, which propelled the Apollo Lunar landing missions, and in the Space Shuttle main engines, all with the continued involvement of Lewis experts.

The expertise gained in large part from the many ground-based, low-gravity studies of hydrogen fuel, lead, in the 1990's, to Lewis becoming NASA's leader in the microgravity research areas of fluid physics and combustion science.

NASA Lewis' work was always broader than propulsion. As new opportunities and challenges arose in space exploration and in the Nation, the Center conducted research in commercial communications technology and space electrical power.

When existing frequencies for television and other satellite transmissions services began to fill up, Lewis researchers applied technology from its early research with electric propulsion to invent a high-efficiency, high-powered transmitting tube. The new tube's increased efficiency and reliability greatly lowered transmission costs, opened up a new communications band, and allowed for new applications such as direct-to-home television broadcast and transmissions to remote areas.

When NASA's ambitious mission planners needed good, reliable electricity for their missions within the solar system, the Center contributed many advances in solar cells, fuel cells, and other then exotic electrical power sources for use in space. And when in the 1970's the Nation became very concerned about the use and availability of energy, the Center applied its expertise to those terrestrial environmental concerns. Aeronautics and space systems and techniques were used to improve alternative energy sources such as wind turbines and solar cells.

Despite these new and exciting research areas, the Center never forgot its first mission: aircraft engine development. With increases in commercial aviation traffic, jet engines abounded, but early commercial jet engines were noisy and inefficient. The 1970's and 1980's energy crises and increased environmental awareness brought demands for cleaner, quieter, and more fuel efficient aircraft engines. The Center and its industry partners responded with such programs such as the Advanced Turboprop and the Energy Efficient Engine and developed retrofit techniques that allowed existing engines to be made quieter.

In March 1999, the Center was formally renamed the John H. Glenn Research Center at Lewis Field. The new name honors John H. Glenn, Jr., the first American to orbit the Earth and longtime U.S. Senator from Ohio who made history again in October 1998 by returning to space at the age of 77. The designation of the historic site upon which the Center is built as Lewis Field celebrates the legacy of George W. Lewis. As the Center's aerospace achievement continues, the Glenn Research Center remains on the critical path to achievements in the air and in space.

NASA Glenn celebrates its renaming on May 7, 1999.

Williams International V-Jet II will introduce a new general aviation turbine engine.

Better Engines for Better Aircraft

The growth in the global use of air transport for both people and goods is testimony to its safety and reliability. But that very growth, which is expected to triple within 25 years, means the air transport system must be further improved. The driving force behind these improvements is propulsion—building better engines. NASA Glenn researchers are working with the aviation industry to develop safer, more reliable engines and control systems; quieter, more fuel-efficient engines with fewer harmful emissions; and less flammable fuels. Competitive new engines will revitalize the light aircraft market and make flying on four to six passenger aircraft smoother, safer, quieter, and more affordable. Researchers are working to ensure airplane flights exceeding two times the speed of sound will have a minimal environmental impact and cost about the same as a commercial flight today.

Glenn, as NASA's Lead Center for aeropropulsion, pursues these objectives in specific areas of research including materials, structures, internal fluid mechanics, and instrumentation and controls. As the NASA Center of Excellence in turbomachinery, Glenn is committed to developing innovative technology using its computational, analytical, and experimental expertise for future aerospace programs—from small aircraft engines to high-performance, high-speed hypersonic engines to new rocket engines.

Frozen Assets

For all aircraft operating in cold climates, whether in flight or preparing to take off, ice is an ever-present threat. Ice formation decreases lift. This loss of lift can cause the pilot to lose control of the aircraft and could even result in a crash. NASA Glenn studies ice formation on aircraft surfaces in its Icing Research Tunnel and aboard research aircraft that intentionally fly into hazardous winter weather. The Center has helped develop revolutionary techniques for protecting aircraft from ice formation and training for pilots to handle problems resulting from unavoidable ice formation.

Affordable Access to Space

Today, access to space is limited by the cost of getting to low Earth orbit. To increase our access, researchers are working to reduce launch costs from $10,000 to one $1000 per pound of payload. To achieve this, we need wholly reusable spacecraft. NASA Glenn is contributing its expertise to investigations of several generations of future space launch vehicles.

Trailblazer concept of a rocket-based, combined cycle aerospace plane.

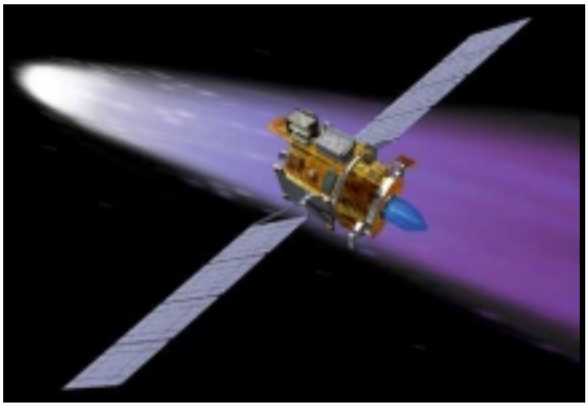
The X-33—a pilotless suborbital plane—will test the viability of a fully reusable, single-stage launch vehicle. If its commercial successor is built, it will depend on several Glenn developments. These include new propellant technologies, engine health monitoring systems, and an automated ground support system.

Increasingly, air and space vehicles are synthesizing not only to push the boundaries of flight, but to blend them. Future space vehicles will truly combine the advantages of aircraft and rockets. The Trailblazer—a low-cost combined rocket and airbreathing engine vehicle—is Glenn's low-risk approach for a vehicle that will operate like an airplane as it climbs through the atmosphere, then switch to rocket mode to reach orbit. A Trailblazer-like vehicle could reduce payload launch costs to hundreds of dollars per pound and help turn space into an even more viable workplace and a truly accessible habitat.

Innovative Exploration

To improve the capabilities of deep space probes and the reliability and longevity of our space data networks and Earth observatories, NASA Glenn is developing new methods for spacecraft propulsion and positioning. Ion engines, once considered the stuff of science fiction, are now being used by industry for satellite stationkeeping, while NASA has begun using them as the primary propulsion source for missions such as Deep Space 1. The Hall thruster—tested at Lewis in the 1960's and developed further by Russia's space agency—is America's newest form of satellite propulsion. Weighing 40 percent less than chemical thrusters, Hall thrusters also may be used to raise satellites to higher orbits and to propel interplanetary spacecraft. Pulsed plasma thrusters are being used for precise positioning of the very small satellites that are forming networks around Earth.

The Center continues to support exploration of the solar system by providing new technologies that expand our knowledge of the universe. Recent contributions include testing of the innovative airbag landing system for the Mars Pathfinder mission. That mission also included three experiments on the Sojourner rover to assess the accumulation and abrasiveness of Martian dust and soil. Glenn engineers designed the traveling wave tube amplifiers now flying on the Cassini probe, currently en route to Saturn. These amplifiers provide the radio link to Earth and will be used in radio science experiments.



Deep Space 1 utilizes NASA Glenn ion propulsion and solar power technology.

Unlocked Mysteries

NASA's Microgravity Science program uses experiments performed in low gravity to learn how gravity affects physical and chemical processes. NASA Glenn leads the efforts in combustion science and fluid physics and supports materials science research. The space environment provides the opportunity to study common natural phenomena and new technology without

NASA Glenn is making significant contributions to the International Space Station.

the masking effects of the Earth's gravity. For example, although combustion provides 85 percent of the United States' energy production, it is still not well understood. Unlocking these mysteries could lead to improvements in fire safety, fuel efficiency, and pollution control here on Earth.

The Glenn microgravity program begins with ground-based low gravity experiments, in the Center's drop towers or aircraft, and proceeds when required to Shuttle or space station experiments. Through 1998, over 40 missions have carried more than 143 Glenn microgravity experiments on the U.S. Space Shuttle and Russian Mir Space Station. Currently, NASA Glenn is developing the Fluids and Combustion Facility for the International Space Station that will be a mainstay in the microgravity program.

A Powerful Future

As people from around the world continue their exploration and development of space aboard the International Space Station, they will rely upon a Glenn-designed electrical power system to harness the Sun's energy. Engineers at Glenn combined state-of-the-art electrical designs with complex computer-aided analyses to design the largest power system ever to be constructed in space. It will contain the world's highest performing, most efficient space solar arrays and energy storage technologies.

NASA's spacecraft require new innovations in power systems. Typical of this is the Deep Space 1 ion propulsion system requirements for high-power solar arrays. NASA Glenn researchers and other design team members combined high-performance solar cells with lenses designed to focus, or concentrate, sunlight on them. The decision was to employ Glenn's Solar Concentrator Arrays with Refractive Linear Element Technology (SCARLET) design concept. Other technologies are being applied for exploration of the Moon and Mars. Options range from traditional solar cells and fuel cells, to more complex electro-mechanical systems.

Advanced Communications

Today's information-based culture wouldn't be possible without the vital links provided by satellites. The cutting edge of this critical communications technology is being shaped at Glenn, where researchers are developing new high data-rate information superhighways that seamlessly connect Earth and space data networks. Glenn is working on a variety of future applications of communications technology including aircraft traffic management and weather information systems.

On September 12, 1993, a new on-ramp to the information superhighway was opened to heavy traffic. On that day that NASA launched its revolutionary Advanced Communications Technology Satellite (ACTS). ACTS is a unique demonstration of advanced communications technologies. Over one-hundred different industry, government, and university organizations have investigated applications in telemedicine, distance learning, and other high data rate projects in support of research activities such as remote facility control and data analysis.

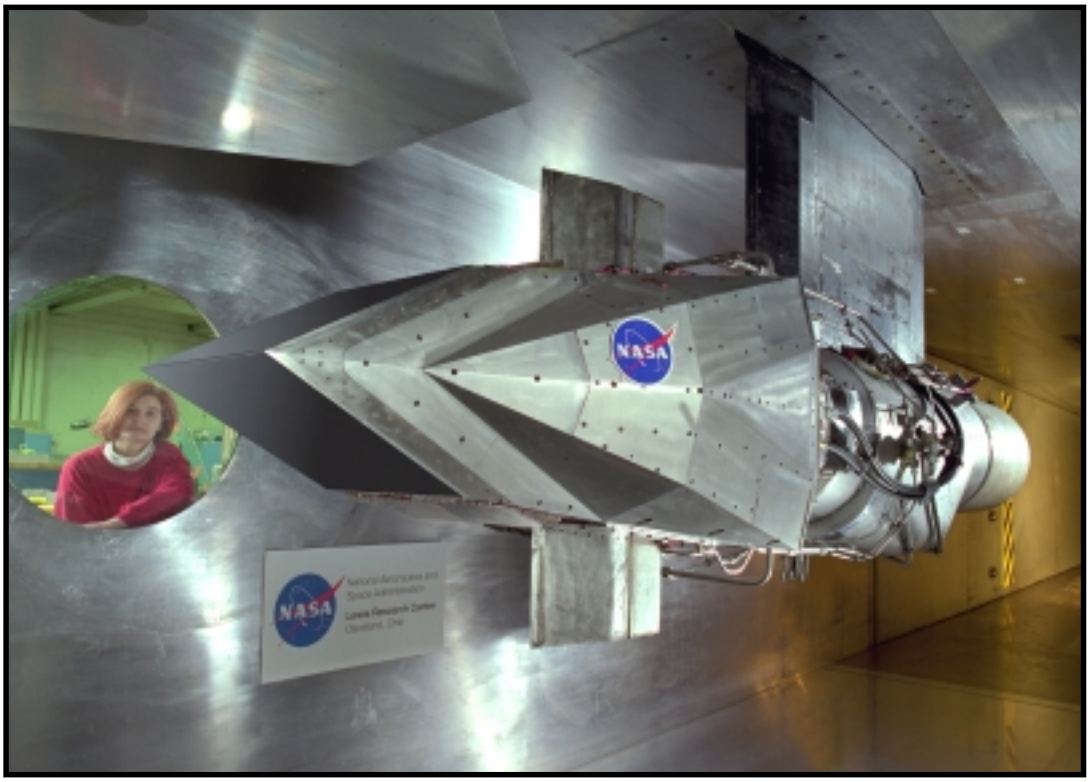
World-Class Facilities

The Glenn Research Center main site, Lewis Field, is a 350-acre campus, adjacent to Cleveland Hopkins International Airport. Lewis Field comprises over 150 buildings that contain a unique collection of world-class facilities. Key aeronautics facilities include five wind tunnels, the Aero-Acoustic Propulsion Laboratory, the Engine Components Research Laboratory, the Propulsion Systems Laboratory, and the Engine Research Building. The Flight Research Building (Hangar) supports aircraft research operations for Glenn's aeronautics, microgravity, solar cell, and icing research.

Several Lewis Field facilities are used to simulate the space environment. These include the Electric Propulsion Laboratory, the 2.2-Second Drop Tower, and the Zero Gravity Research Facility. Spaceflight operations are supported by Space Experiments Laboratory, the Telescience Support Center, and ground stations for satellites. A Fabrication Shop, the Research Analysis Center, and a variety of other operational facilities support all of the facilities.

NASA Glenn also includes the 6400-acre Plum Brook Station near Sandusky, Ohio, 50 miles west of Cleveland. The primary facilities there are the Hypersonic Tunnel Facility, Space Power Facility, the Spacecraft Propulsion Research Facility, and the Cryogenic Propellant Tank Facility.

Since the groundbreaking at Cleveland on January 23, 1941, more than $535 million has been invested in the Center's capital plant. The estimated replacement cost is over $2.2 billion. While some facilities have been operational since 1944, all have been outfitted with highly complex mechanical, electrical, and data acquisition devises. The work done in Glenn's unique, world-class facilities continues to push technology to



The 10- by 10-Foot Supersonic Wind Tunnel is one of five wind tunnels at NASA Glenn.

Titan/Centaur shroud jettison testing at Plum Brook's Space Power Facility.

its limits and breaks through to new levels of exploration and invention.

Superior Staff

Looking back on Glenn's long and varied history of significant contributions to advances in aeronautics and space flight, it is easy to fix our focus on technological marvels or on the exploits of the heroes who broke the sound barrier and walked on the Moon. Behind them have been thousands of dedicated people, experts in their technical fields and crafts and in project management. Today, over 3600 people staff Glenn, including civil servants and support service employees. Over half of them are scientists and engineers, who plan, conduct, oversee, and report on the research tasks and projects of the Center. Technical specialists, skilled workers, and administrative staff assist them.

Leading experts and innovators—and many of America's brightest young engineers and scientists—have joined the Glenn community. Partnerships with universities and industry create a rich exchange of knowledge. Glenn Research Center's collaborative relationships with other NASA Centers make it a vital part of an extraordinary NASA team—a team that is leading the way in expanding the frontiers of air and space.

Recognized Leadership

While all technical roads may not lead to NASA Glenn, many certainly emanate from the Center, its facilities, laboratories, and researchers. Glenn experts are regularly requested to sit on technology review boards and consult with other government agencies and industry in their areas of expertise. Glenn's testing facilities are used by our industry partners and by international space agencies. The amazing success of NASA Glenn's work has garnered the Center numerous awards including an Emmy, a Collier Trophy, and 74 *Research & Development Magazine*'s IR-100 awards, which the *Chicago Tribune* has called "the Oscars of invention."

Improved Life and Living

Although thoughts about Glenn may conjure images of satellites, rocket ships, and high tech jet engines, the Center has contributed to some very down-to-earth products. Glenn has assisted hundreds of companies in turning aerospace technologies into marketable products. One recent example is a method to quickly clean the surface of paintings evenly and without touching the painting. The technique uses atomic oxygen, like that found in low-Earth-orbit, to create a chemical reaction that lifts smoke damage and dirt from paintings.

Along with the everyday and artistic marvels, Glenn has had considerable impact in more critical industries as well. Glenn's contributions to medicine have revolutionized diagnoses, research, treatment, and surgeries. For example, Glenn helped the Cleveland Clinic design a permanently implantable, artificial heart pump—the Innovative Ventricular Assist System. The pump takes over for the heart's damaged left ventricle, the part that does most of the pumping.

Preparing the Next Generation

To ensure America's place as a technology leader, NASA Glenn recognizes the vital importance of preparing tomorrow's engineers and scientists. Air and

space flight have the unique ability to inspire young minds. Using this interest as a foundation, NASA Glenn has created many programs that encourage students to explore and understand science and technology. Ultimately, it is hoped that by engaging these students during their academic lives, they will take up science and technology as a career.

New Horizons

The Glenn Research Center drives the engine of innovation. The Center's expertise continues to be critical to NASA's future missions in air and space. As private and commercial aviation expands, NASA Glenn will propel aircraft to new standards of performance and efficiency. When America decides it is time for human missions to Mars and beyond, NASA Glenn engineers and scientists will be ready to provide advanced power, propulsion and communications technology that ensure fast, reliable transportation and science activities for the crew. No matter where that next horizon is found, these pioneers and innovators will make it possible for us to travel beyond it.

Heart pump developed with the Cleveland Clinic.

For more information contact:

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